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RECORD OF INVENTION

LLNL-I.P.L.G.

LLNL File No.  
**IL-10883**

This invention was made in the course of or under prime Contract No. W-7405-ENG-48 between the U.S. Department of Energy and the University of California. This Record of Invention is prepared for the Office of the Assistant General Counsel for Patents, U.S. Department of Energy.

**I. Title of the Invention**

Radial Reflection Diffraction Tomography

**II. Inventor(s):** those who conceived the invention

LLNL Inventor(s) (First, Middle, Last)	Title/Position	Directorate	Payroll Acct	Phone Number	Mail Stop
Sean K. Lehman	Engineer	EE/DSED			154

Non-LLNL Inventor(s) (F M L)	Title/Position	Employer	Phone Number	Fax Number	Subcontract #

**III. Abstract of the Invention**

This is a new application of diffraction tomography to an annular, outward-looking geometry. An annular array of transducers, or a single or pair of co-located transducers, either electromagnetic or acoustic, directed radially outward, launch a pulse and record the reflected backscattered field. The measured backscattered field is then used in a diffraction tomography reconstruction algorithm to create an image of the material or structure surrounding the transducers.

A diffraction tomographic imaging algorithm has never been developed for this geometry.

The transducers can be located at the end of a catheter which is inserted or "snaked" into an object or part under evaluation.

**IV. Uses of the Invention** (List past uses, current uses and potential uses for your invention)

LLNL or Government uses or possibilities for use:

- Bore hole tomographic imaging;
- Nondestructive evaluation (NDE) applications such as weapon or material part imaging.

Commercial or other uses or possibilities for use:

- Medical applications such as intravascular ultrasound (IVUS) imaging of blood vessel walls; intestine; prostate.

**V. Keywords for Searches**

A. Potential Licensees: list keywords for appropriate companies to contact concerning your invention.

- Medical equipment manufacturers (see IVUS systems, prostate imaging systems)
- Geophysical companies (bore hole tomography)

B. Patent search: list keywords for an effective patent search.

- Diffraction tomography, radial geometry, reflection mode, outward-looking.

**VI. Duty of Disclosure:** Each individual associated with the filing and prosecution of a US patent application has a duty of candor and good faith in dealing with the US Patent and Trademark Office. This includes a duty to disclose all information known to that individual to be material to patentability. Failure to disclose this information can result in the invalidation of a patent resulting from this disclosure.

**A. Documents Describing the Invention**

Please list documents, publications, and presentations describing the invention that you have published or prepared for publication, or presented on the subject. Also include presentations and publications planned within one year from now. Please attach a copy of preprints, articles, or viewgraphs.

Title/Subject	Date	Publication #
Engineer's notebook.		
RRDT seminar. Viewgraphs only. No handouts		
Radial Reflection Diffraction Tomography for Intravascular Imaging with Application to Classifying Atherosclerotic Plaque		

**B. Documents Describing Prior Art**

Please list and provide copies of all related documents, including patents and journal articles. Please include patent numbers, authors, title, publication date, etc.

Title/Subject	Date	Publication #

**VII. Background of the Invention**

Please describe the background of the invention: what is the technical problem addressed by the invention and what solutions have been used in the past by others (successfully or unsuccessfully).

Intravascular ultrasound (IVUS) imaging provides a method for imaging the interior of blood vessel walls. In standard acoustical imaging techniques, a catheter with a rotating ultrasound transducer is inserted into a blood vessel. The transducer launches a pulse and collects the reflected signals from the surrounding tissue. Current imaging systems use a B-scan mode, whereby images are formed from the envelope of the received signal and by assuming straight ray theory (geometrical optics). These images suffer from the consequences of ray theory of sound propagation which does not model its wave nature.

I propose to develop a new imaging algorithm using diffraction. The technique will still make use of the backscattered field received by current cylindrical IVUS probes. However, because this technique will process both the phase and amplitude of the reflected signal and will properly account for the wave nature of the propagation, it can provide imagery with superior resolution and contrast of both the absorption and sound speed over that provided by existing IVUS systems. The technique is referred to as "radial reflection diffraction tomography" (RRDT) because of the radial configuration of the transducer and the tomographic paradigm used to reconstruct the structure of the tissue from the reflected waves.

The Center for Subsurface Sensing and Imaging Systems (CenSSIS) is a National Science Foundation (NSF) engineering research center headquartered at Northeastern University in Boston, MA. LLNL is a Strategic Affiliate of CenSSIS. Northeastern University, Boston University, and LLNL have applied as CenSSIS members to NSF for funding to develop RRDT into the next generation of



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IVUS systems. We will have support from the Massachusetts General Hospital (MGH), and the medical equipment manufacturers of Boston Scientific and Analogic to build a prototype device.

**VIII. Detailed Description of the Invention**

Please describe the invention in detail and include drawings to show the invention (you may also attach a paper).

See attached documents:

**IX. Inventor Information**

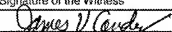
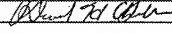
Inventor's Permanent Home Address			
Full Name	Citizenship	Street Address	City, State, Zip Code
Sean K. Lehman	USA	4348 Valley Avenue	Pleasanton, CA 94566

**X. Funding Source**

Please list the funding source or project under which the invention arose - include subcontracts, CRADAs, international agreements, work for others, or special project information:

Resource Manager	Phone #	Is funding presently being provided for development of your invention?	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
		Please state the source of funds (if same as above, please so state):	
Subcontract #	DOE Program Code	Do you expect future funding from the current source or other sources?	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
CRADA #	Work for Others #	If yes, what is that source?	

**XI. Conception of the Invention**

Conception Date	Conception Place		
Names of Witnesses or others with knowledge of facts relating to conception (preferably at least 2):			
Full Name	Signature of the Witness	Organization	Telephone #
James V. Gandy		LLNL	422-8675
David H. Chambers		LLNL	423-8893

### XII. Reduction To Practice of the Invention

Date first model completed:	Date of operation and testing:	Place of test:	
Results of testing:			
Witnesses or others with direct knowledge of reduction to practice or testing (preferably at least 2):			
Full Name	Signature of the Witness	Organization	Telephone #

### III. Invention Use and Disclosure

Has the invention been put into use?	<input type="checkbox"/> Yes <input type="checkbox"/> No	If yes, explain:
Has the invention been disclosed to non-LLNL personnel?	<input type="checkbox"/> Yes <input type="checkbox"/> No	If yes, to whom and when?
If yes, was the disclosure done under a non-disclosure agreement?	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Name		Date

XIV. I/We believe myself/ourselves to be the first and original inventor(s) of the above-described invention. It is recommended that the witness to the conception of the invention (Section XI) and/or the witness to the reduction to practice of the invention (Section XII) be the one who witnesses the signature(s) of the inventor(s).

Inventor Signature	Date	Witness Signature	Date
<i>Sean Feltman</i>	May 29, 2001	<i>James V. Presley</i>	May 29, 2001

### XV. Inventor MUST obtain review by Authorized Derivative Classifier:

Basis for unclassified release:		
<input type="checkbox"/> Outside scope of AEA and EO		
<input type="checkbox"/> CG-DAR-1, Topic(s):		
<input type="checkbox"/> Other Guide(s):		
Topic(s):		
UCNI	<input type="checkbox"/> Yes <input type="checkbox"/> No	If YES, Guide
Authorized Derivative Classifier	Name and Title	Signature
Confirming Reviewer	Name and Title	Signature

## XII. Reduction To Practice of the Invention

Date first model completed:	Date of operation and testing:	Place of test:	
Results of testing:			
Witnesses or others with direct knowledge of reduction to practice or testing (preferably at least 2):			
Full Name	Signature of the Witness	Organization	Telephone #

## III. Invention Use and Disclosure

Has the invention been put into use?	<input type="checkbox"/> Yes <input type="checkbox"/> No	If yes, explain:	
Has the invention been disclosed to non-LLNL personnel?	<input type="checkbox"/> Yes <input type="checkbox"/> No	Name	Date
If yes, was the disclosure done under a non-disclosure agreement?	<input type="checkbox"/> Yes <input type="checkbox"/> No	If yes, to whom and when?	

XIV. I/We believe myself/ourselves to be the first and original inventor(s) of the above-described invention. It is recommended that the witness to the conception of the invention (Section XI) and/or the witness to the reduction to practice of the invention (Section XII) be the one who witnesses the signature(s) of the inventor(s).

Inventor Signature	Date	Witness Signature	Date
<i>John F. Holman</i>	May 20, 2001	<i>James V. Conboy</i>	May 20, 2001

**XII. Reduction To Practice of the Invention**

Date first model completed:	Date of operation and testing:	Place of test:	
Results of testing:			
Witnesses or others with direct knowledge of reduction to practice or testing (preferably at least 2):			
Full Name	Signature of the Witness	Organization	Telephone #

**III. Invention Use and Disclosure**

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Inventor Signature	Date	Witness Signature	Date
<i>Sean Feltner</i>	May 29, 2001	<i>James V. Casady</i>	May 29, 2001



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**XVI. For LLNL Patent Group Use Only**

Possible Statutory Bars	Publication
	Public Use/Sale
Recommended Filing Date Due to Possible Statutory Bars	
Preliminary Review by:	Date

**Send the completed and signed form to the Patent Group at L-703**